iSELF: The development of an Internet-Tool for Self-Evaluation and Learner Feedback

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Abstract: This paper describes the theoretical basis and development of the iSELF: an Internet-tool for Self-Evaluation and Learner Feedback to stimulate self-directed learning in ubiquitous learning environments. In ubiquitous learning, learners follow their own trails of interest, scaffolded by coaches, peers and tools for thinking and learning. Ubiquitous learning solutions include on- and off-line, formal and informal learning. To benefit from its possibilities, learners need to develop competencies for self-directed learning. To do so, a self-evaluation tool can help the learner to get insight in his/her own development, to manage and monitor his/her own learning process, to collaborate in learning, to relate the learning to 'real life' needs, and to take control over educational decisions. The iSELF was developed in an iterative process, complying to the following high level requirements: (1) Enabling learning anytime, anywhere; (2) Supporting self-directed learning; (3) Evaluating learner, learning solutions and job-needs; (4) Assessing learner competencies; (5) Using card-sort method for questionnaires; (6) Facilitating questionnaires 'under construction'; and (7) User-friendly design. The resulting online tool contained a card-sort module, looking somewhat like a 'solitaire' game, a profile module to evaluate core competencies, and a feedback module to suggest learning possibilities. For illustration, 14 different studies that contributed to the development of iSELF and to the development of self-evaluation questionnaires compliant to iSELF, are briefly discussed. These illustrative studies included various populations: e.g. students, employees from small and medium enterprises, crisis management organizations, and the military. Usefulness and usability of the self-evaluation tool were valued positively. The iSELF contributes to an adaptive ubiquitous learning environment in which the learner can make the educational decisions according to self-directed learning principles. The iSELF will stimulate self-directed learning in a ubiquitous learning environment and will help to create learners for life.

Keywords: self-evaluation, self-assessment, internet-tool, ubiquitous learning, self-directed learning, feedback

1. Introduction

1.1 Ubiquitous learning needs self-directed learners

Nowadays, technology is very much part of everyday life and work (Mork 2011). Information and knowledge is handled and shared by using ubiquitous technology; ICT that makes it possible to access information 'anytime, anywhere' (Adkins et al. 2002). A learning environment that makes use of this technology is often referred to as 'ubiquitous learning'. This is a way of learning in which learners follow their own trails of interest, scaffolded by coaches, peers and tools for thinking and learning (Dieterle & Dede 2007). Ubiquitous learning solutions include on- and off-line, formal and informal learning.

The availability of ubiquitous learning possibilities may assume that learners are able to learn and will develop themselves anytime, anywhere (G. D. Chen et al. 2008). However, this assumption might be too ambitious. Since the ability to manage one's own learning is becoming increasingly important, one of the goals of education should be to create learners for life. Learners for life can be described as learners who have a flexible and pro-active attitude toward learning and developing themselves (Du Bois & Staley 1997). In this context the concept of self-directed learning is often mentioned and intensively discussed (Collins 2004).

In a review study of Stubbé &Theunissen (2008), five crucial elements of self-directed learning were identified:

- *Learner control:* Control over educational decisions and learning process.
- *Self-regulating learning strategies:* Skills that support the learner to manage and monitor his/her own learning process (e.g. setting goals, planning, problem solving, and strategy use).
- *Reflection:* The combination of self-assessment and self-evaluation on both the performance and the learning process that gives the learner insight in his/her own development.

- *Interaction with the social environment:* The interaction with others, learners and teachers/coaches, in order to determine what goal should be set, discuss in what way this goal can be achieved, cooperate and collaborate during the learning process and ask for help.
- *Interaction with the physical environment:* The learning experience should be set in the 'real world' and should relate to 'real-life' (work)situations.

Reality shows that some people develop a self-directed attitude toward learning, especially in relation to work or a hobby, others do not (Collins 2004). Explicitly teaching self-regulating learning strategies or reflection and stimulating (perceived) learner control, helps learners to become more self-directed (Stubbé & Theunissen 2008). Therefore, a ubiquitous learning system must not only provide the learner with learning resources anytime and anyplace (C.-M. Chen & Li 2010). It must also actively provide the learner with the appropriate learning possibilities for self-directed learning (Hiemstra 2006; S. L. Wang & Wu 2011). Self-directed learners are not merely consumers of learning facilities, they should also be able to contribute to the facilities by sharing knowledge and supporting other learners (Koper et al. 2005).

Self-evaluation (also called 'self-monitoring' or 'self-assessment') refers to an individual systematically observing his/her own behaviour and performance. Realistic self-evaluation will help the learner to gain self-regulatory control (Boekaerts 1991). Therefore, to become a self-directed learner, one should get insight in one's own development. During self-evaluation, the learner makes a comparison between the noted behaviour and some designated standard (Hughes et al. 1991). In order to be able to assess his/her performance realistically, the learner must have access to internal standards of performance, involving a definition of what is meant by a 'good' or 'adequate performance. A person acquires these internal standards and self-conceptualizations on the basis of his experiences but also on the basis of statements made by significant others and self-attributions (Boekaerts 1991). Therefore, peer or expert observation can help learners to evaluate their own opinion about themselves. Self-evaluation as motivator for future behaviour agrees with Bandura's Social cognitive theory of self-regulation, assuming that a person can become can become knowledgeable about his/her own capabilities and skills (Bandura 1991).

Although self-evaluation presumes higher order cognitive skills, it is proven to be possible even in populations of people with mild cognitive retardation (Hughes et al. 1991). There are indications that self-reported abilities and competencies have concurrent validity with ratings by others, although it is found that self-assessment can be somewhat more positive (Jones & Fletcher 2004; Kelso et al. 1977). *Moreover*, 'People may not be right about themselves, but their self-evaluations are the ones that most powerfully affect their future behaviour' (page 45, (Byrnes 1984). As a result, self-evaluations are relevant for learner behaviour.

Thus, self-evaluation will help the learner to get insight in his/her own development, to manage and monitor his/her own learning process, to collaborate in learning, to relate the learning to 'real life' (work)needs, and to take control over educational decisions. In this way, all five elements of self-directed learning, mentioned before, are stimulated by self-evaluation.

2. Assessment of competencies

To answer the question: 'What to evaluate?' we specifically look at the fifth element of self-directed learning: *Interaction with the physical environment.* Learning needs to be related to 'real-life' (work)situations, because meaningful knowledge is constructed only when process of learning integrates with cultural and life contexts (C.-M. Chen & Li 2010). In our rapidly changing society, initial training alone cannot meet the need for the development of working individuals. Training results become obsolete the moment they are obtained. A flexible and innovative economy requires permanent adaptations of knowledge, skills and attitudes, also called 'competencies'. Competencies are indivisible clusters of skills, knowledge, conduct, attributes and notions (e.g. (Boekaerts 1991). They are context dependent, connected to activities and tasks, but also flexible in time (van Merriënboer et al. 2002). In their essence, competencies can be used in more situations than the current task. This means that when one's job changes, the acquired specific skills become obsolete, but the acquired competencies can still be useful. Nevertheless, in our fast changing society it is possible that competencies themselves become obsolete or less important.

Another characteristic of competencies is that they can be acquired by learning and development. Competencies can be valuable to match individual performance and career planning with organizational job needs (Marko & Savickas 1998). In that context the concept 'core competencies' is used, competencies which

are essential for certain tasks or positions (Case 2003) and as such will provide the content for the relationship with 'real-life' work situations.

Reporting on one's behaviour poses a difficult cognitive task and participants' reports are influenced by the wording of questions, format, and content (Schwarz & Oyserman 2001). In a study on self-assessment for selection purposes it was found that measurement conditions have substantial positive impact on the quality of self-ratings (Jones & Fletcher 2004). Self-ratings appeared to improve for instance when social comparison instructions were given; when they expected external validation; the anonymity of raters, previous self-assessment experience, unbalanced, positively toned scale; motivational instructions; framing questions unambiguously, ensuring measures are tied to actual performance, specifying the time period under consideration (i.e., past, present, or future behaviour); competencies broken down into distinct dimensions. However, it was also found that individual and gender differences were substantial and should be taken into account (Jones & Fletcher 2004). A self-evaluation instrument in a ubiquitous learning environment needs an easy to use, flexible and reliable method to gather information on selected competencies. A card-sort method is such a method, with good psychometric characteristics (Lievens & Sanchez 2007). Card-sorts involve the placement of cards onto piles, based on how each participant feels the concepts or statements on them are related. When using this method for evaluation of competencies, competency statements can be placed on the cards. Former research with this technique showed that people are able to sort a large number of separate cards in a relatively short time, which will increase learners' motivation to use it for evaluation. The technique is particularly useful for identifying the common ground between a larger and diverse collection of competencies with a large and diverse group of participants (Caldwell & O'Reilly 1990).

There are two approaches in card-sort: the free and the restricted procedure (Harper et al. 2003). In the free approach, a participant is allowed to make as many piles of related cards as necessary, and label them. In the restricted approach, a participant uses piles that have already been defined (e.g. questionnaire Likert scales like 'not applicable at all' to 'totally applicable'). This enables the use of statistical techniques to cluster related competency statements into core competencies. The restricted card-sort relies less on the categorization skills of the participants. This makes it useful for a sample with various levels of education and experience, as is the case in a ubiquitous learning environment. Moreover, a standardized categorization makes it possible to make learner profiles that can be related to peers and that can show development over time. The same categorization can also be used to evaluate job-needs or the available learning solutions. An automatic match of the learner profiles with the learning solution profiles will show if they are beneficial to the learner. The results should be presented as suggestions so that the learner can make the educational decisions according to self-directed learning principles.

The aim of this paper is to describe the development of the iSELF: an Internet-tool for Self-Evaluation and Learner Feedback to stimulate self-directed learning in a ubiquitous learning environment. The theoretical background and characteristics of the iSELF, based on the developments so far, will be discussed. In addition, the first experiences with the tool and the matching self-evaluation questionnaires will be illustrated on the basis of 14 different studies.

3. The iSELF itself

3.1 High level requirements

With the introduction text in mind, a set of requirements was developed for the iSELF:

1. *Enabling learning anytime, anywhere:* available for every learner through internet, with the possibility to embed the tool into Learning Management Systems.
2. *Supporting self-directed learning:* helping the learner to get insight in his/her own development, to manage and monitor his/her own learning process, to collaborate in learning, to relate the learning to 'real life' (work)needs, and to take control over educational decisions. To support control and to provide a 'safe' learning environment, it is important that the learner is the only one who can see personal evaluation results, until he/she decides otherwise.
3. *Evaluating learner, learning solutions and job-needs:* possibility of using the same content: (a) to score the learner competencies of all kinds of learners (e.g. low and high educated), (b) to assess the learner competencies by the learners themselves or by peers, colleagues, coaches or subject matter experts, invited by the learner, (c) to score which competencies are trained by certain learning solutions or are

relevant for a job or position. Using the same content in all situations enables a comparison between them.

4. *Assessing learner competencies:* assessing competencies that are specific for a group of learners in their (work)situations, and at the same time generic enough to remain relevant in our rapidly changing society.
5. *Using card-sort method for questionnaires:* this technique is less time-consuming and more objective than other methods. This will increase motivation to use it in a large and diverse group of participants.
6. *Facilitating questionnaires 'under construction':* with new developments in the workplace, new competencies will become important. Therefore, new questionnaires will be developed all the time.
7. *User-friendly design:* most people do not like questionnaires. A playful appearance, user-friendly operation and clear, relevant content will increase motivation.

3.2 Design

The overall structure of the iSELF is presented in Figure 1 and explained in the next paragraphs.

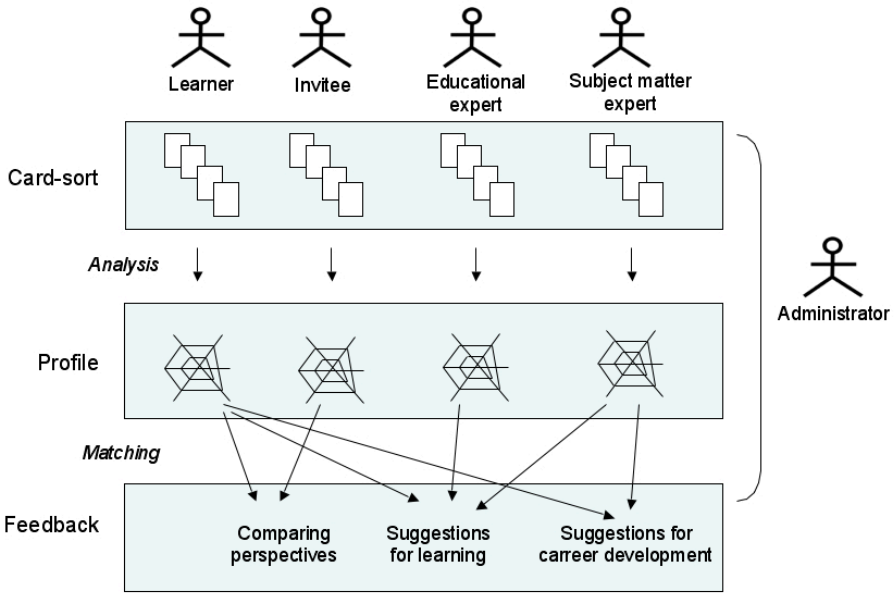

Figure 1: Overall structure

3.2.1 Users

The overall structure includes the following iSELF users:

1. *Learner*: the learner in a ubiquitous learning environment.
2. *Invitees:* peers, colleagues, coaches or subject matter experts, invited by the learner to assess the learner.
3. *Educational expert:* the evaluator of available learning solutions.
4. *Subject matter expert:* the evaluator of competency requirements for a job or position.
5. *Administrator:* administrates the tool content: competency statements, information about core competence clusters and reference group- or norm figures.

3.2.2 Card-sort

The appearance of the card-sort tool, a front-end input module, is somewhat like a 'solitaire' game (see Figure 2). Instead of sorting playing cards, learners sort competency statement cards on their importance. The tool offers the possibility to get an overview or skip a statement temporarily. The competency statements are formulated in such a way that they are easy to comprehend for people with different backgrounds. A second person singular verb at the beginning of every statement emphasises the fact that competencies express themselves in behaviour (E.g. 'Cooperates with people from other organizations' or 'Uses ICT systems to collect information and knowledge quickly'.) These statements can be used with different overall opening questions. For the learner the opening question could be: 'In the last two weeks, was this applicable to you?' For the invitee it would be: 'In the last two weeks, was this applicable to [name learner]?' For the use with the learning

solutions of job-requirements: 'Is this applicable to [name learning solutions or job]?' The card-sort module was built using Adobe Flex, an open source framework for building rich Internet applications that are delivered via the Flash Player 6.0.

Figure 2: Card-sort module in input mode

3.2.3 Profiles

The profile module shows the results of the card-sort input to the learner. After analyses, the competency statements are clustered into core competencies. The results are presented to the learner in one or more graphs. It can show learner results in combination with reference scores or scores from former sessions. The profile module was built using ColdFusion 8.0, a rapid application development platform that includes advanced features for enterprise integration and enables the development of rich Internet applications.

3.2.1 Feedback: suggestions for further learning

The feedback module can be used to compare perspectives by interpreting the results of both the learner and the invitee. The feedback can also be used to provide suggestion for learning solutions beneficial to the learner or for job-training and selection. The feedback is based on an automatic match of the learner scores with the learning solution scores. The feedback module was built using ColdFusion 8.0.

3.2.2 Administration

The administration module, a back-end module, combines several input functions: overall opening question, statements, number and content of answering categories, assignment of statements to clusters, personal accounts, data export, reference or norm score input. The module was built using ColdFusion 8.0 running Railo Server, the main version of Railo (a compiler) which can be integrated into standard web servers. It is suitable for production use.

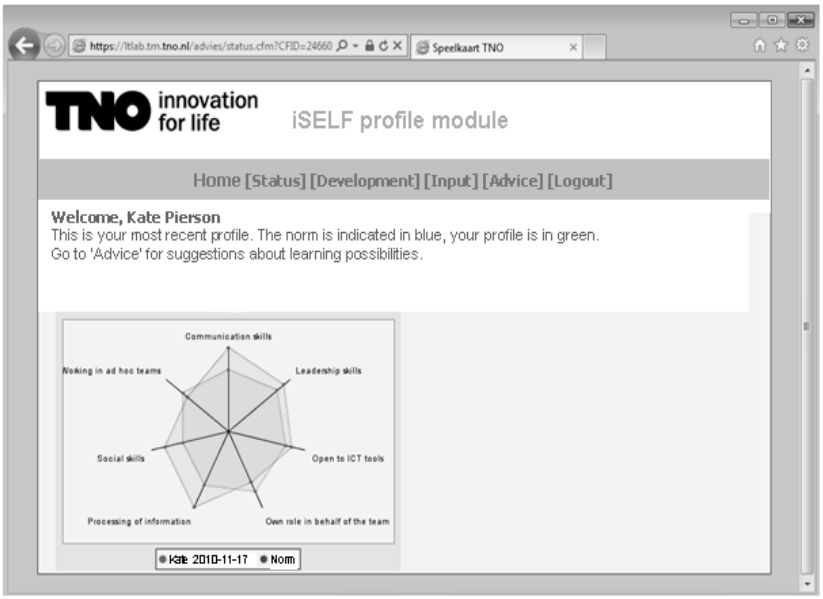

Figure 3: A learner profile

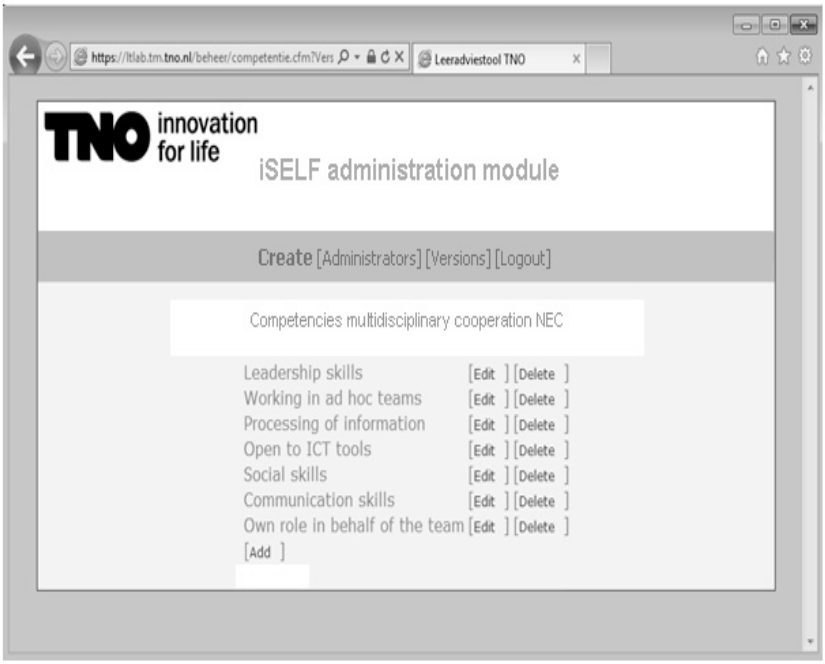

Figure 4: Administration of competencies

3.2.3 Content: psychometric sound questionnaire

The content of the iSELF card sort module is created according to social sciences standards in questionnaire construction (Schwarz & Oyserman 2001). Currently, four questionnaires are under development (see Table 1). The presented scales are based on theoretical concepts and data analyses so far (more information can be obtained from the authors). At any moment in the development of a questionnaire it is possible to export the data for statistical analyses for validation and reliability tests. Using a.o. principal component analysis (factor analyses) and Cronbach's alphas (≥ 0.7), clusters can be identified and transformed into scale scores. The results from these analyses can be fed back through the administration module. The data export option can also be used to perform additional statistical analyses for group comparisons and determination of the influence of background variables like age or experience. These possibilities make the iSELF not only a learner tool but a scientific tool as well.

Table 1. Questionnaires developed in iSELF-style

Questionnaire	No. Scales	Scales	items	Example of item
Competencies for deploying simulators in Military training (ComSim)	5	Using simulators, Coaching, Advising, Teaching and Organizing, Accurate planning and documentation.	65	'Translates learning goals into the possibilities of a certain simulator'
Competencies for multidisciplinary cooperation in a Network Centric Organization (NCOQ)	7	Leadership skills, Working in ad hoc teams, Open mind for ICT tools, Own role in behalf of the team, Informatin processing, Social skills, Communication skills.	71	'Cooperates with people from other organizations'
Competencies for Self-directed Learning Questionnaire (CSLQ)	5	Learner control, Self-regulating learning strategies, Reflection on learning and performance, Collaborative learning, Reflection on relevance for work.	32	'Chooses what to improve in your work'
Military leadership competencies (MilLead)	8	Communication, Take initiative, People oriented, Employee development, Organization orientation, Planning and organizing; Results-oriented, Vision	40	'Takes the personal situation and wishes of others into account'

4. The iSELF: development in phases

The development of the iSELF was an iterative process in which the modules (card-sort, profile and feedback) were prototyped, built and tried successively. Experiences were gathered using 14 different studies with various study aims and designs. All studies contributed to the development of the iSELF and will briefly be discussed as illustration of the iSELF possibilities. The general characteristics of the studies are presented in Table 2. More information about these studies can be obtained from the authors.

4.1 Phase 0: Prototyping with a paper card-sort tool

4.1.1 The paper-based iSELF

In this paper-based version, the iSELF only contained the card-sort module. The selected competency statements were each placed on a paper cards. Together with this set of cards came five envelopes with the labels ‘not important’, ‘somewhat important’, ‘important’, ‘very important’ and ‘essential’. A participant could express the importance of a competency statement for a position by assigning the cards to the envelopes. In this way, a 5-point Likert-scale was created for each statement.

4.1.2 Context

The paper-based prototype was used for career planning using core competencies (see Table 2, study 1). Semi-structured interviews and a document study resulted in 65 cards with competency statements. Subject matter experts sorted the cards twice for their own function: on expert and on novice level. In a group discussion both the method and the content of the cards was discussed. Using principal component analysis, five core competencies could be identified.

4.1.3 Experiences

The participant sorted the large set of statements cards quickly: each round of 65 cards took about 5 to 15 minutes. Most participants were positive about the procedure and preferred it to a standard questionnaire. The card-sort module was considered useful.

Table 2. General characteristics of the studies with iSELF

Refr. nr.	iSELF modules used	**Questionnaire *(1)***	N	Domain	Subjects characteristics	Study aim	**Research type *(2)***
1	Prototype Card-sort	ComSiM	28	military	Subject matter experts training-related functions in the Royal Netherlands Army	Identification of competencies for career planning	obs
2	Card-sort	NCOQ	158	crisis management organizations	Members of safety regions (fire department, police force, medical troupes, office of a dike-reeve)	Development of an instrument for self-assessment of Competencies for Network Centric Organizations	obs
3	Card-sort	NCOQ	74	military	Navy personnel involved in Information Management	Translating Lessons Learned into Education and Training, case Information management	obs
4	Card-sort	CSLQ	16	Research institute	Researchers behavioural and social sciences	Determinants for innovation in multi-disciplinary teams	obs
5	Card-sort	CSLQ	22	training and organization consultancy agency	Teachers and Consultants	Measuring competencies for self-directed learning	obs
6	Card-sort	CSLQ	86	crisis management studies	Students	Serious gaming intervention, effect on self-directed learning	quasi
7	Card-sort	CSLQ	335	SMEs	Employees from 22 SMEs in the potato, vegetable & fruit retail business	Assessing the learning culture	obs
8	Card-sort	CSLQ & NCOQ	40	crisis management organizations	CoPI members from 4 different safety regions.	Development of a tool to Improve Team Situation Awareness in multidisciplinary Crisis Management Teams	exp
9	Card-sort	CSLQ	57	Military	Personnel from the Royal Netherlands 1th-CIMIC (Civil-Military Cooperation) battalion	Development of a ubiquitous learning environment	obs
	Card-sort	CSLQ	43	Military	Navy personnel	Training instructors in using the Job Oriented Training approach	obs
10	Card-sort, Prototype Profile,	CSLQ	66	Military	Navy personnel	Minimal e-coaching intervention to support social learning in an online Community of Practice	exp

Refr. nr.	iSELF modules used	Questionnaire *(1)*	N	Domain	Subjects characteristics	Study aim	Research type *(2)*
11	Card-sort, Prototype Profile,	CSLQ	29	Military	Personnel from the Royal Netherlands National Reserve Corps	Minimal e-coaching intervention to support self-directed learning using e-mail	exp
13	[regular online questionnaire], Profile, Feedback	MilLead	79	Military	Royal Netherlands Air Force, Military rank: Sergeant-major to Captain.	Development of an instrument for self-assessment and invitee-assessment of leadership competencies	obs
14	Card-sort, Profile, Feedback	CSLQ	11	Crisis management organizations	COPI and ROT members from different safety regions	Usability pilot	obs

(1) see Table 1 for more information about the questionnaires
(2) obs=observational, quasi= quasi-experimental, exp: experimental; [Decision rule: I: are the subjects randomly assigned to conditions? II: has the experimenter functional control over independent variable(s): I yes+ II yes = exp.; I no+II yes = quasi.; I no+ II no = obs.]

4.2 Phase 1: Learner-profiling

4.2.1 The iSELF alpha version

This version contained an internet based card-sort module and a half-automatic prototype of the profile module. The card-sort module was transformed in an online version, looking like a 'solitaire' web-game. The prototype profile module used MS Excel to produce a graph and MS Word for handmade individual reports.

4.2.2 Context

The alpha version was tested in three steps: (1) several try-outs of the card-sort module, (2) the profile module was added and presented to the learners and (3) the effect of receiving and discussing a personal profile was tested. To try out the card-sort module, various self-evaluation questionnaires were developed (see Table 1) and psychometrically tested in crisis management organizations, the military and with employees from small and medium enterprises (see Table 2, study 2-11 & 13). The iSELF was presented to the participants from within a learning management system (ILIAS, MOODLE) or with a hyperlink in an email. The data-output of the card-sort module was used to identify core competencies using the statistical package SPSS.

Next, in one of these studies, the participants received a personal profile about their Self-directed learning competencies. A group of Navy personnel received a profile after a pre-post-test intervention study (see Table 2, study 10). The profile showed the individual results on three points of measurement and the overall average scores of the whole group. Afterwards the participants were interviewed.
Finally, in one study (see Table 2, study 11) military personnel participated in an experiment in which the experimental group received their profile and minimal e-coaching by email. Compared to the control group, their taking control for their learning increased significantly because of the intervention.

4.2.3 Experiences

The card-sort module of the iSELF alpha version was used successfully: the technique worked, questionnaires could be validated and the participants valued the module positively. The profile prototype was evaluated as useful in the communication with the participant. Moreover, receiving and discussing a profile in itself improved some aspects of self-directed learning.

4.3 Phase 2: Prototyping the match of learner profiles with learning solutions profiles

4.3.1 The iSELF beta version

This version contained all iSELF-functionalities (card-sort, profile, feedback).

4.3.2 Context

The beta version was tested in two steps: First, the profile and feedback modules were used as an addition to a 'classic' online-questionnaire embedded in MOODLE. It was developed for self-assessment and invitee-assessment of leadership competencies in Air force personnel (see Table 2, study 12). The suggestions the participants received from the feedback module included formal (training, e-learning) and informal learning possibilities (e.g. documents, discussion, movies). The employees could choose to use the iSELF or not and could invite others to assess them if they wished. The next step was a usability pilot (see Table 2, study 13) with the complete iSELF that was carried out with employees from crisis management organizations. Afterwards participants were interviewed about their evaluations.

4.3.3 Experiences

In the Air Force case, using the iSELF was voluntary. Many employees did use it and their numbers are still increasing. In the usability pilot, participants were enthusiastic about the iSELF. One of the conclusions was that matching the learner profile with learning possibilities saves time and will improve adaptation of the learning environment to the learner. These experiences indicate that the tool is usable and useful.

5. Discussion and conclusions

This paper describes the iterative development, testing and evaluation of the iSELF: an Internet-tool for Self-Evaluation and Learner Feedback. The tool is designed to stimulate self-directed learning in a ubiquitous learning environment and our experiences so far confirm its usefulness.

The experiences with the *card-sort module* in a large and diverse group of participants proved that the technique was highly appreciated. When they had the possibility to use it anytime and anywhere, participants used it voluntarily. The playful appearance, the user-friendly operation and the clear, relevant content increased motivation to use it.

The *profile module* helps the learner to gain insight in his/her own development in relation to the competencies important for his/her work. These competencies always need to be identified before they can be used in the iSELF. We emphasize the importance to assess competencies that are specific for a group of learners, and at the same time generic enough to remain relevant in our rapidly changing society. This helps the learner to reflect on 'real life' (work)needs.

The possibility to compare their results with previous results or with those of invited peers, colleagues, coaches or subject matter experts, seemed to improve reflection as intended. In future, it is possible to include e-coach possibilities that will stimulate reflective competencies more explicitly.

The *feedback module* presents suggestions for learning, which helps the learner to manage and monitor his/her own learning process and to take control over educational decisions.

An important requirement for the iSELF is that it should support learning anytime, anywhere. Some organizations use Learning Management Systems (LMS) to provide learning solutions like e-learning, others use the LMS as a portal and offer links to learning solutions outside the LMS. Therefore, the iSELF needed the possibility to be embedded into Learning Management Systems. The beta version was tested both inside and outside an LMS and could thus be used anytime and anywhere. LMS also offer the possibility to monitor the learner's progress. When the iSELF is used within an LMS, it is possible to make the learner profiles available for monitoring.

In spite of these positive findings, it is clear that there are some limitations and many challenges left in our quest to provide learners with a self-assessment and feedback tool for self-directed ubiquitous learning. For instance, it is technically possible to use the iSELF for selection purposes by combining the job-requirements

with the individual competencies. However, to support learner control and to provide a 'safe' learning environment, it is important that the learner is the only one who can see personal evaluation results, until he/she decides otherwise. Therefore, we use this tool exclusively for learning or career suggestions and not for selection. It is, however, possible to combine the individual results and present them an average on group-level, for organizational purposes.

As described in the introduction, ubiquitous learning is a way of learning in which learners follow their own trails of interest, scaffolded by coaches, peers and tools for thinking and learning (Dieterle & Dede 2007). It includes on- and off-line, formal and informal learning. To support all that, the iSELF should be available through internet independent of the learning solution chosen. iSELF was not tested for off-line learning solutions and therefore we do not know if learners who prefer off-line solutions will use the on-line iSELF. Future research should look into this limitation. However, the other way around does not present any problems: the on-line iSELF can refer to off-line learning solutions. The profile of any learning solution that is evaluated by educational experts can be included. As such the iSELF can be used for both formal and informal learning.

Another challenge that influences the usefulness of the iSELF is that in a self-directed ubiquitous learning environment there is no pre-defined learning content and learners can select content from on- and off-line, formal and informal learning (Gütl et al. 2011). Especially informal learning can help learners to collaborate with others when learning, a requirement for self-directed learning. Of course, it is almost impossible to provide profiles of all possible learning solutions. To start with, the most useful or important learning possibilities for a certain group of learners can be profiled. In addition, it might be possible to ask learners for suggestions for useful *learning* solutions, which in itself increases collaborative learning.

When judging the match of learning solutions with the learners profile, a personalisation of learning solutions is needed to knowledge level, goals and other characteristics of individual learners (Papanikolaou et al. 2002). For adaptation, one has to consider both the content and the didactics of a learning solution. There are interesting developments concerning content adaptation to the learners profile: one option is to filter out unsuitable course materials to reduce cognitive load (Barker 2011). To do so, for instance the Automatic test item creation can be used (Gütl et al. 2011), or content selection based on item response theory (C. M. Chen et al. 2005). However, one has to bear in mind that for self-directed learners, technology must not take away control from the learner, but in stead provide stimuli to increase competencies for self-directed learning. In that respect didactical adaptation to the learner's profile is needed. Coaching and instruction style must fit the learners need for personalized learning guidance. In our study with minimal e-coaching, it appeared that receiving and discussing a profile in itself improved some aspects of self-directed learning. There are interesting developments concerning the adaptation of the didactical approach to the learner's profile as well: for instance in the development of Intelligent Support for Discovery Learning (Veermans, De Jong, & Van Joolingen, 2000). Veermans et al (2000) showed that it is possible to develop algorithms that provide the learner with advice, while preserving the open nature of the discovery environment.

A limitation of the presented work is that the development in phases was performed using many different studies and convenience samples. Some of the development iterations would have been different if a dedicated science program with sharply defined samples could have been used. On the other hand, the large amount of studies in different domains, with different sets of competencies and with different study designs, provided many challenges that helped us to develop a better tool. As a result the iSELF was developed to be not only a learner tool but a scientific tool as well. Extensive analyses could be made using the output of the card-sort. Plus-point of the card-sort was the absence of missing data and a good response. It facilitated questionnaires 'under construction' so one can keep up with new developments and new competencies needed in the workplace.

A flexible and innovative economy requires permanent adaptations of knowledge, skills and attitudes. Formal, initial training alone cannot meet the need for the development of working individuals to face these challenges. There is, therefore, a growing need for self-directed, flexible and innovative employees who can and will keep on learning throughout their entire lifespan. Research had shown that fostering students to become self-regulated learners is complicated and should be seen as a long-term process (Van den Boom et al. 2007). The iSELF will stimulate self-directed learning in a ubiquitous learning environment and will help to create learners for life.

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